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ABSTRACT

Behaviors that characterize play with convergent and divergent materials and the effects of play on convergent and divergent problem solving were examined in this study. Seventy-two 3- and 4-year-old children were assigned to one of three conditions: (1) play with convergent materials; (2) play with divergent materials; and (3) non-play control. The play materials, five sets of nine pieces which fit into five formboards, could be used as puzzles (convergent activity) or play blocks (divergent activity). All children participated individually in three 10-minute sessions. After the third session, each child was given two divergent and four convergent problem-solving tasks. There were marked differences in play behaviors with convergent and divergent materials. The formboards directed children playing with convergent materials to spend two-thirds of their time filling the formboards. The divergent play group performed better than the convergent play group on a divergent thinking task. The convergent play group used more strategy based moves in solving the convergent tasks. (Author/MP)

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The Effects of Play on Convergent and Divergent Problem Solving

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Abstract

This research examined the behaviors that characterize play with convergent and divergent materials and the effects of play on convergent and divergent problem solving. There were 72 three and four year old children assigned to one of three conditions: (1) play with convergent materials; (2) play with divergent materials; and (3) non-play control. The play materials, five sets of nine pieces which fit into five formboards, could be used as puzzles (convergent activity) or play blocks (divergent activity). All children participated individually in three ten-minute sessions. After the third session, each child was given two divergent and four convergent problem-solving tasks. There were marked differences in play behaviors with convergent and divergent materials. The formboards directed children playing with convergent materials to spend two-thirds of their time filling the formboards. The divergent play group performed better than the convergent play group on a divergent thinking task. The convergent play group used more strategy based moves in solving the convergent tasks.

This research examined the effects of play on problem-solving. Two types of play experience were provided; children were allowed to play with either convergent materials (those that tend to direct play to a single solution, in this case, puzzle solving) or divergent materials (those that facilitate a variety of play activities). Following the play experience, the children were presented with both convergent and divergent problem-solving tasks. Observations of the play and problem-solving sessions provided information about the processes underlying play and problem-solving and the relations of these different play experiences to two types of problem-solving.

There is a widespread belief among developmental psychologists and educators that play is a medium through which children develop cognitive skills. Although numerous studies claim a developmental function for play, there is little research to confirm the relation between play and problem-solving. In general, theorists have postulated several elements of play experience that might contribute to the development of problem-solving skills. First, investigation or exploration of objects is presumed to provide information about them (Hutt, 1976; McCall, 1974). Attending to and experimenting with the properties of objects during play might direct the child to a strategy of attending to such properties in problem solving. Second, experimentation in play may contribute to flexibility in the child's responses (Bruner, 1976). Through object exploration and play, the child may develop a broad repertoire of skills and a tendency to experiment that could transfer to the mastery of problems requiring a novel solution or a variety of solutions. Third, play may allow the child to exercise existing skills and intelligence (Bruner, 1976; Smilansky, 1968). Finally, the fantasy element of play may facilitate the transition from concrete to

abstract thought leading the child to early symbolic thinking (Fein, 1979; Piaget, 1962; Vygotsky, 1976). An example is the child's developing the ability to pretend that a block is a house; this newly formed capacity to abstract can be practised and varied in play. Such representational thought may facilitate solving a problem that requires the formation of a mental model or symbolic thought (e.g., What could this block be?).

Solving convergent problems

A convergent problem has one and only one solution. Although several studies have examined the efficacy of play for solving convergent problems, the results are equivocal or of limited generality since they are restricted to one task -- joining sticks together to obtain a lure. Generally, this research has shown that children given play experience with the sticks performed better on the task than children who had no experience.

Sylva, Bruner & Genova (1976) compared the effect of play experience to observation of a principle required for the task and to a no treatment condition. Although the play group was clearly superior to the no treatment condition in their task performance, the superiority of the play group as compared to the observe principle group is tenuous. The authors reported that children in the play group required fewer hints, had more goal-directed responses, and were categorized as "learners" more frequently (i.e., moving from simple to complex means) as compared to children in the observe principle condition. They failed to note that almost half of the successful children in the observe principle group solved the problem on their first attempt and, therefore, did not require any hints, did not need more than one goal-directed response, and were not categorized as "learners" although they had clearly learned the solution.

Two other studies have extended the research of Sylva et al. Vandenberg

(1978) examined a larger age range and tasks of varied difficulty and found a similar difference in task performance in favor of the group with play experience, as compared to instructional experience. The replication, however, held only for a task very similar to the one used by Sylva, and not for a simpler task. Smith and Dutton (1979) extended the play versus training paradigm to direct and innovative problem-solving. When the training session related directly to the task of joining two sticks together, the play and training groups were equivalent in their problem-solving performances and both were superior to a control group. On a more complex task of joining three sticks together, which had not been directly taught to the training group, the play group performed better than both the training and control groups indicating that play experience may be beneficial for a task which requires innovative transfer.

Solving divergent problems

Play has been shown to facilitate solving a divergent problem -- one which has no single correct solution, but a variety of possible solutions. Dansky and Silverman (1973) investigated the effects of play with objects on solving a divergent problem in which the children were asked the alternate uses for those objects. Children who had play experience were superior to an imitation and a control group on the number of non-standard responses to the objects. In a subsequent study, this result was replicated using different objects in the play and task conditions indicating that the benefits of play experience generalize to solving problems with unfamiliar objects (Dansky and Silverman, 1975).

A recent study by Dansky (1980) examined the role of make-believe play in enhancing divergent thinking studies. Preschool children were observed during free-play, categorized as either players (who displayed make-believe)

or non-players, then assigned to one of three treatment conditions (free play, imitation, and problem-solving). Children who were "players" and had free-play experience were superior to all the other children on an alternate-uses test. This study showed that providing children with free play experience will not necesarily enhance divergent thinking, but that it is make-believe activity in play which is crucial in facilitating divergent thinking.

Play activities that contribute to problem solving

The research to date has raised several questions about the relation between play and problem-solving. First, a review of the related theories suggests that different elements of play may relate to different learning experiences. If these elements of play are present in varying degrees in different forms of play, one might expect related differences in subsequent problem-solving. The studies reviewed above have examined the effects of play on problem-solving, but have failed to document the different elements in the play experiences that might contribute to differential problem-solving. The current research has examined the play behaviors associated with convergent and divergent materials and related these to subsequent problem-solving performance. Second, the only convergent problem examined in previous research has been that of joining sticks together to obtain a lure and the only divergent problem has been an alternate uses task. The current research has extended the range of both convergent and divergent problems presented following play experience. Finally, all play experiences provided in the previous studies have been divergent in nature, that is, not directed themselves to the solution of a set problem. The current research adds to the earlier data base by considering the effects of both convergent play on both convergent and divergent problem-solving thereby providing an

extension and integration of the casual evidence from previous play research.

The author has conducted two studies of play and problem solving, but will only be detailing the results of the second study in this paper. In summary, the first study (Pepler, 1979) revealed marked differences in play with convergent as compared to divergent materials. The children who played with the divergent materials were also shown to perform better on a divergent thinking task than either the convergent play group or control groups. There were no differences among the groups on convergent problem-solving measures.

The second study served as a replication of: (1) the differences in play behavior with convergent and divergent materials and (2) the effect of play on divergent problem solving. It extended the findings of the first study by including another divergent thinking task and convergent tasks which were more similar to the convergent play materials.

Method

The children. The sample comprised 72 children from three daycare centres in southern Ontario. The children were equally divided by sex and age, 3 years old ($\underline{M}$ = 3.6) and 4 years old ($\underline{M}$ = 4.6). They were English speaking and generally middle class.

Materials. There were five sets of play materials. A set consisted of nine different-colored pieces which fit into a white formboard. The five sets of materials were animals, vehicles, regular shapes, random shapes and squares. They could be used either as a puzzle by fitting the pieces into the formboard, or as play blocks since the pieces were 1.9 cm. thick and were free-standing.

Design. The children were randomly assigned to one of three conditions balanced for age and sex. The three conditions were: (1) play with

convergent materials, (2) play with divergent materials, and (3) non-play control. All children were seen individually for three ten-minute sessions conducted on separate days within a five-day period; a battery of problem solving tasks was administered on the day of the last session.

Experimental Setting. The play and non-play control sessions were conducted in a separate room in each daycare centre, away from the main activity area. A camera, videotape recorder and monitor were set up prior to the sessions. Children in all conditions were videotaped during the three sessions.

Procedure. In the convergent play condition, the children had all five sets of play materials including both the formboards and the pieces. It was assumed that the formboard suggested a problem with a single solution -- a convergent activity. In the divergent play condition, the children had the pieces, but not the formboards; therefore, there was no correct solution for the play activity, but a variety of possible play uses -- a divergent activity. Children in both play conditions were asked simply to play with the toys. Children in the non-play control condition were not exposed to the play materials, but spent an equal amount of time reading books with the experimenter.

Play behaviors. From the videotapes of the convergent and divergent play sessions, the following play behaviors were analyzed; (1) Form -- labelling the shape of a block, grouping three or more blocks of similar shape, or fitting forms together and comparing forms; (2) Color -- labelling the color of a block or grouping three or more blocks of the same color; (3) Representation -- labelling the real meaning of a representation (e.g., car), labelling a feature of a representation (e.g., ears of the rabbit), labelling a fantasy meaning for a representation (e.g., calling

the triangle a house), representing a block with sounds (e.g., barking with dog), or grouping three or more blocks of similar meaning (e.g., vehicles); (4) Investigation -- visual and manual investigation, investigation of standing properties, investigation of rolling properties, or other types of investigation; (5) Construction -- construction of a tower of three or more blocks with a single block as the base, or construction of a horizontal structure with three or more blocks on a base of at least 2 blocks; and (6) Symbolic play -- symbolic play with a realistic representation (e.g., making the rabbit hop), symbolic play with a fantasy representation (e.g., shooting the T-shaped block as a gun), or denoting a symbolic meaning for a construction. In addition, the time spent assembling the puzzles was recorded in the convergent play condition.

Reliability. In addition to the experimenter, a second observer independently scored 16 sessions for inter-observer reliability. The percent agreement was calculated by dividing the number of agreements by the number of agreements and disagreements. A disagreement was scored when one observer recorded a behavior that the other had missed or when the observers did not agree on the categorization ofa behavior. The average inter-observer agreement was 78.6%; the range for the categories was 70.0-87.1%).

Problem-solving tasks. Two divergent and four convergent problem-solving tasks comprised the dependent measure. These were presented in counterbalanced order by a second observer who was blind to the group membership of the children. The order of presentation within both the convergent and divergent blocks of tasks was also counterbalanced. The divergent tasks were a Structure Meaning Task and an Alternate Play Uses Task. For the Structure Meaning Task, the experimenter built three structures with the play material pieces and in turn asked the child to give as many

labels to the structures as possible. This task was scored for the number of responses and the number of unique responses (no other children gave the same response). For the Alternate Play Uses Task adapted from Dansky and Silverman (1973), the child was presented with two sets of three blocks (vehicles and random shapes) and was asked in turn to tell or show the experimenter as many ways as possible that one might play with the blocks. This task was scored for the number of responses, both verbal and demonstrative, the number of constructions, and the number of unique responses. Interobserver reliabilities, averaged across measures, for the Structure Meaning and Alternate Play Uses Task were 94.8% and 87.6%, respectively.

The four convergent tasks were puzzles with six pieces that fit into six subtly different sized spaces; any given piece would only fit into one space (see Figure 1). Each puzzle included two cues; one led to a correct solution while the other was irrelevant to the problem. In other words, a puzzle designed to be matched on form had the same six colors on the pieces as in the spaces; however, matching on the basis of color did not solve the puzzle. There were four puzzles: (1) Form -- a form matching puzzle with irrelevant color cues; (2) Representation -- a representation matching puzzle with irrelevant color cues; (3) Color (form) -- a color matching puzzle with irrelevant form cues; and (4) Color (representation) -- a color matching puzzle with irrelevant representation cues.

The puzzles were designed with a misleading element in order to examine the use of strategies in the process of solving the convergent tasks. For example, in solving a puzzle for which form was the relevant match and color was irrelevant: (1) a correct strategy would be to match a blue square with a red square, (2) a wrong strategy would be to try to match a blue square with a blue triangle, and (3) a trial and error move would be to try to

match a blue square with a black circle. The latter move could represent a random response made in an attempt to solve the puzzle or it could represent a strategy in itself if the child systematically tried a single piece in all of the spaces or all of the pieces in a single space. The children's performance on these tasks were scored from videotapes and analyzed according to: (1) the total number of moves, (2) the number of runs (a series of one or more moves with the same piece), (3) the time taken to complete a puzzle, (4) the porportion of correct strategy moves, (5) the proportion of wrong strategy moves, and (6) the proportion of trial and error moves.

Proportion scores were chosen for the analyses as they reflected the use of strategies or a trial and error approach more accurately than the total number of such moves. A high number of moves would over-estimate the strategy base of problem solving. For example, as compared to a child who solved a puzzle with only a few moves, a child who made many moves would have scored higher on all measures: strategy based moves, and trial and error moves. Although the latter child would have higher scores of strategy moves, the former child's problem solving would likely have been more strategy based.

Results

Play measures. Play behaviors of the children in the two play conditions were analyzed with a 2 (play condition) x 2 (age) x 2 (sex) analysis of variance (see Table 1). There were some age and sex differences in play behaviors, but since they did not qualify the group differences they are not reported.[1] Children in the convergent play condition tended to focus on the task demand inherent in the materials; they spent an average of 68% of the time during the three sessions assembling the puzzles. In contrast, children in the divergent play condition manipulated the pieces in a wide variety of ways, exhibiting more investigation, construction, grouping by

properties, and symbolic play. The differences in play behaviors were replications of differences found in the previous study with the exception of investigation of rolling and other types of investigation which were exhibited more frequently by children in the divergent play condition in this study. There were some age and sex differences in play behaviors, but since they did not qualify the group differences, they are not reported.

Insert Table 1 about here

Divergent problem-solving measures. The divergent problem solving results were analyzed witha 3 (group) x 2 (age) x 2 (sex) analysis of variance. Based on the results of the previous study, the divergent play group was expected to give more unique responses on the Structure Meaning Task, but the differences did not reach significance in comparison with the convergent play group, $F(1,60) = .87$, $p \leq .35$, or the control group, $F(1,60) = 2.83$, $p \leq .10$. There were no differences among the groups in the number of responses on this task (see Table 2).

Insert Table 2 about here

The evidence from the Structure Meaning Tasks in the two studies is not conclusive. The previous study found a highly significant difference in favor of the divergent play group, which was not found in this study, although the results were in the same direction. When the results of the two studies are combined statistically, as suggested by Cooper (1979), the combined probability of finding such a difference in the number of unique responses on the Structure Meaning Task, when there actually is no

difference is less than .006 for the difference between the convergent and divergent play groups.

The children in the divergent play group did perform better on the Alternate Play Uses Tasks; they gave significantly more unique answers than the children in the convergent play group, $F(1,60) = 4.2$, $p \leq .05$. The difference between the divergent play group and control group on this measure was not significant. There were no differences among the groups on the number of responses or the number of constructions and no age or sex difference on any of the divergent problem-solving measures.

Convergent problem-solving measures. The effect of play on convergent problem-solving was examined with the same analysis of variance described above. Group differences were found on three of the convergent task measures; these are discussed below (See Table 3). Planned comparisons were made between the convergent and divergent play groups and between the convergent play group and the control group. When comparisons were made among the scores on the puzzles only one, comparing the Form and Representation puzzles with the Color (form) and Color (representation) puzzles, was statistically significant and will be discussed below. The other comparisions of Form and Representation puzzles and of Color (form) and Color (representation) puzzles did not yield reliable differences.

Insert Table 3 about here

Number of runs. The groups differed in the number of runs taken to complete the Form (F) and Representation (R) puzzles as compared to the Color (form) (CF) and Color (Representation) (CR) puzzles, $F(2,48) = 3.27$, $p \leq .05$. The divergent and control groups did not differ markedly in the number of

runs on the two types of puzzles. In contrast, the convergent play group took the fewest number of runs to complete the Form and Representation puzzle and the greatest number of runs to complete the color puzzles (M conv. F&R=6.95, M conv. CF&CR=9.29). On the Form and Representation puzzles the convergent play group took significantly fewer runs than the control group ($F(1,47)=12.24$, $p \leq .002$) and tended to take fewer runs than the divergent play group ($F(1,47)=3.02$, $p \leq .09$). The superiority in proficiency of the convergent play group appeared to be limited to the Form and Representation puzzles as there were no differences among the groups on the number of runs taken to complete the color puzzles.

Proportion of strategy based moves. In order to examine the use of strategies in solving the convergent tasks, the groups were compared on the proportion of strategy based moves, which included both correct and wrong strategy moves. There was a significant difference among the groups in their use of strategy moves (M conv. = .79, M div. = .70, M control = .70), $F(2,48) = 4.74$, p .01; (see Table 3 for group means of each puzzle). The convergent play group used a significantly greater proportion of strategy based moves than the divergent play group, $F(1,48)=6.59$, p .01, whereas the divergent group used a greater proportion of trial and error moves in completing the puzzles (M div.=.30, M conv.=.21). There was also a significant difference between the convergent and control groups on the contrast of the Form and Representation puzzles with the Color(form) and Color(representation) puzzles, $F(1,48)=4.38$, p .04. When presented with the Form and Representation puzzles, the convergent group had a high proportion of such moves (M conv.=.83, M control=.73). When solving the Color puzzles, children in the convergent group decreased their strategy based moves to the level of the control children, whose proportion of strategy based moves was equivalent for both types of puzzles (M conv. = .75, M control = .72). The divergent group,

which had the lowest proportion of strategy based moves overall, was similar to the control group with the Form and Representation puzzles ($\underline{M}$=.72) but had the lowest proportion of strategy based moves on the Color puzzles ($\underline{M}$=.67). This means that the divergent play group increased their trial and error moves when confronted with the color strategy puzzles, suggesting that they may have had a more flexible or more elementary approach to solving a difficult puzzle than either the convergent play or control groups.

Proportion of wrong strategy moves. There was a significant difference among the three groups in the proportion of wrong strategy moves on the contrast of Form and Representation puzzles with the Color(form) and Color(representation) puzzles, $F(2,48)=3.21$, $p \leq .05$. There was a significant puzzle by group interaction between the convergent and control groups on this measure, $F(1,48)=6.35$, $p \leq .02$. When presented with the Form and Representation puzzles, the convergent group had the lowest proportion of wrong strategy moves, whereas the control group had the highest proportion ($\underline{M}$ conv. F&R=.13, $\underline{M}$ controlF&R=.21), however, when presented with the Color(form) and Color(representation) puzzles, the convergent group used a much larger proportion of wrong strategy moves of the control children remained the same ($\underline{M}$ conv. CF&CR=.26, $\underline{M}$ control CF&CR=.19).

The proportion of wrong strategy moves of the divergent play group fell between those of the convergent play and control groups on the puzzle contrasts. There was a trend for the divergent group to make fewer wrong strategy moves overall than the convergent group. $F(1,48)=2.83$, $p \leq .10$. When presented with the Form and Representation puzzles the divergent play group made as few wrong strategy moves as the convergent play group ($\underline{M}$ conv.=.13, div.=.14) suggesting that the divergent play group may have been solving the puzzles according to relevant strategies or trial and error. When presented with the color strategy puzzles, the performance of the divergent group was similar to that of the control group ($\underline{M}$ div.=.20, $\underline{M}$ control=.19).

Discussion

What behaviors characterize play with convergent and divergent materials?

The results indicated more differences than similarities in play behaviors with convergent and divergent materials. The mere presence of the formboards in the convergent condition seemed to constrain the activities of the children.

The play behaviors with convergent and divergent materials may be related to four processes through which play contributes to development: (1) investigation, (2) experimentation and flexibility, (3) exercise, and (4) the transition from concrete to abstract thought. First, by investigating children develop an understanding of the properties of the play materials. The children who played with the divergent materials exhibited more diverse types of investigation during their play and, therefore may have learned more about the properties of the play pieces than the children who played with the convergent materials. Children in the convergent play group may also have gained specific information about the pieces since they had to attend to the form, color, and representation properties as they placed the pieces into the formboards. One question that was raised by this research and merits future examination is whether investigating during play, in addition to providing specific learning, generates a response set to investigate the play materials which transfers to subsequent problem-solving.

The second process, experimentation and flexibility in play, may be present in diverse investigation of rolling and standing properties, construction activities and symbolic play activities.

In addition to specific responses which they can transfer to problem-solving, the children who have experimented during play may continue to be experimental and flexible in response to a problem situation.

In contrast, the children who played with the convergent materials seldom engaged in diversive behaviors. The repetition of puzzle solving during the three play sessions may involve the process of exercise or practice in play. The majority of the children playing with the convergent materials appeared to be unable to break their convergent response set of solving the puzzles and explore divergent uses of the convergent play materials. Hence the assumption that the presence of a formboard would place a task demand on the play situation was substantiated. This finding may have implications for other types of convergent play materials, such as formboards, puzzles, or coloring books, which also may inhibit diverse activity.

The final mechanism is learning through symbolic play which facilitates the transition from concrete to abstract thought. This occurs when a child attributes meaning to a simple piece or a group of pieces in a construction, which is presumed to facilitate and develop the child's capacity to think in the abstract (Vygotsky, 1976). Since children engaged in significantly more construction with the divergent materials they might be expected not only to have a more flexible approach to the pieces, but also to be more familiar with symbolic uses of the pieces than children who played with the convergent materials.

The differences in play clearly point to the influence of materials in a play situation. The convergent play materials of this research are similar to the cognitive materials designed by Montessori (1965). As Montessori contended, such materials, which are designed to elicit attention to properties and strategies which relate to the properties, may direct children to self-discovery through play. This research suggests, however, that the learning may be limited to the "lesson" inherent in convergent materials.

Play with convergent materials may contribute to learning through exercise and investigation, although the current research did not directly evaluate this possibility. A preliminary indication of the role of exercise in play may come from the convergent group, which repeatedly solved the same puzzles rather than turning to the more diversive activities that were possible with the pieces. Subsequent research could incorporate a fine-grained analysis of the behaviors specific to play with convergent materials to test the effects of exercise.

What are the effects of play on convergent and divergent problem solving?

The research described in this paper indicated that overall the convergent play group used more strategies in their problem solving; however, the majority of the moves made by all of the children were based on the correct strategy. Group differences emerged in the use of the two alternatives to the correct strategy, namely, the use of incorrect strategies and the use of trial and error, especially when solving the color puzzles. The children in the convergent play group tended to use the strategies whether or not they were appropriate; when confronted by a problem in which a salient cue was irrelevant, children who played with the convergent materials tended to persist with a reasonable, but inappropriate strategy.

The children who played with divergent materials in this study did not use strategies in solving convergent problems as consistently as children who had played with convergent materials. Instead, these children had a higher proportion of trial and error moves, especially on the color puzzles which suggests that they may have had a more flexible approach to solving a puzzle with a less salient strategy. This effect is similar to the findings of Sylva et al (1976) and Smith and Dutton (1979) who reported that children who played with materials in a divergent manner were more flexible or innovative in their use of hypotheses to solve a convergent problem.

The effects of divergent play on divergent problem solving also indicated greater flexibility in problem solving by the divergent play group. The results of the current research were consistent with those of other studies (Dansky and Silverman, 1973, 1975). Children who had divergent play experiences were more imaginative in their responses to divergent problems, giving more unique responses to divergent thinking tasks, than children who had convergent play experiences.

The comparison of the effects of play with convergent and divergent materials suggested that the effects of convergent play experiences were very specific, whereas the divergent play experiences transferred more generally. The specificity of the transfer of learning from convergent play experiences was demonstrated in the first study (Pepler, 1979) in which the convergent problem solving tasks were not of a formboard type similar to the convergent play materials. On these different tasks, the convergent play group were similar to the convergent play materials and provided the opportunity to observe strategy based or trial and error moves in problem solving. On these tasks the problem solving of the convergent play group was generally more proficient and more strategy based. These results indicate that the limited context of convergent play experience produced learning effects that were limited to solving similar convergent problems.

Play experience with the divergent materials appeared to transfer much more generally. Even though the divergent problem solving tasks were not similar to the divergent play experience, the children who had played with the divergent materials were more flexible and unique in their responses. The flexibility elicited by playing with divergent materials even seemed to transfer to the convergent tasks; the divergent play group appeared to be more flexible in abandoning ineffective strategies as they sought problem solutions.

In general this research demonstrated that there are beneficial, short-term effects of playing with convergent and divergent materials. The descriptive data suggested that exercise and investigation in play might facilitate convergent problem solving, whereas investigation, experimentation, and symbolic play might facilitate divergent problem solving. In future research, it will be important to examine the long-term effects of cumulative play experience with convergent and divergent materials. The results of these studies suggest that play experience could be a powerful tool for shaping problem solving abilities by systematically relating the type of play experience to the desired learning effects.

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Footnote

1. Age and sex differences were analyzed and some reliable differences were found (Pepler, 1979). The effects did not qualify the group differences, however, and are therefore not reported. That information is available from the author.

Table 1

Comparison of Play Behaviors

Mean Frequency Across Three Sessions

	Convergent Play	Divergent Play	F(1,40)	p
Labelling				
Label form	1.08	1.49		
Label color	3.27	1.50		
Label real representation	9.72	12.60		
Label representation features	.13	.29		
Label fantasy representation	.47	.79		
Represent by sound	2.22	3.07		
Grouping				
Group form	.34	2.16	13.90	.001
Group color	.05	1.04		
Group representations	.29	2.42	20.10	.001
Investigation				
Visual/manual investigation	.11	1.83	16.33	.001
Investigation of standing	.17	1.16	11.95	.001
Investigation of rolling	.28	.95	4.30	.045
Other investigation	.75	2.66	6.23	.016
Fit/compare form	.21	3.84	12.12	.001
Construction				
Tower	.43	5.10	21.00	.001
Horizontal	1.33	6.88	33.97	.001
Symbolic Play				
Play-Real	5.64	13.80	5.83	.020
Play-Fantasy	.16	.83		
Play-Construction	.26	1.57	8.80	.005

Table 2

Mean Scores of Groups on Divergent Problem-Solving Tasks

	Convergent Play	Divergent Play	Control
	M	M	M
STRUCTURE MEANING TASK			
Number of responses	16.8	16.0	13.2
Number of unique responses	4.6	5.9	3.2
ALTERNATE PLAY USES			
Number of responses	10.0	13.2	11.0
Number of constructions	5.9	5.7	4.3
Number of unique responses	2.1	4.0	2.1

Table 3

Group by Puzzle Means of Convergent Task Measures

	Form	Representation	Color (form)	Color (representation)
1. Proportion of Correct Strategy Moves				
Convergent Play	.76	.63	.49	.48
Divergent Play	.65	.55	.45	.49
Control	.55	.48	.55	.51
2. Proportion of Wrong Strategy Moves				
Convergent Play	.10	.17	.24	.28
Divergent Play	.11	.15	.18	.21
Control	.17	.26	.19	.19
3. Proportion of Trial and Error Moves				
Convergent Play	.14	.20	.26	.24
Divergent Play	.24	.30	.37	.30
Control	.28	.26	.26	.30
4. Total Number of Moves				
Convergent Play	9.75	11.79	14.21	15.13
Divergent Play	13.75	13.46	15.83	17.58
Control	15.00	14.79	13.96	14.13
5. Number of Runs				
Convergent Play	6.67	7.25	8.99	9.59
Divergent Play	7.04	8.50	8.46	8.88
Control	9.59	9.46	8.88	8.90
6. Time to Completion (sec.)				
Convergent Play	46.29	62.88	106.09	114.67
Divergent Play	70.08	80.54	95.71	114.08
Control	82.87	99.29	91.13	98.79

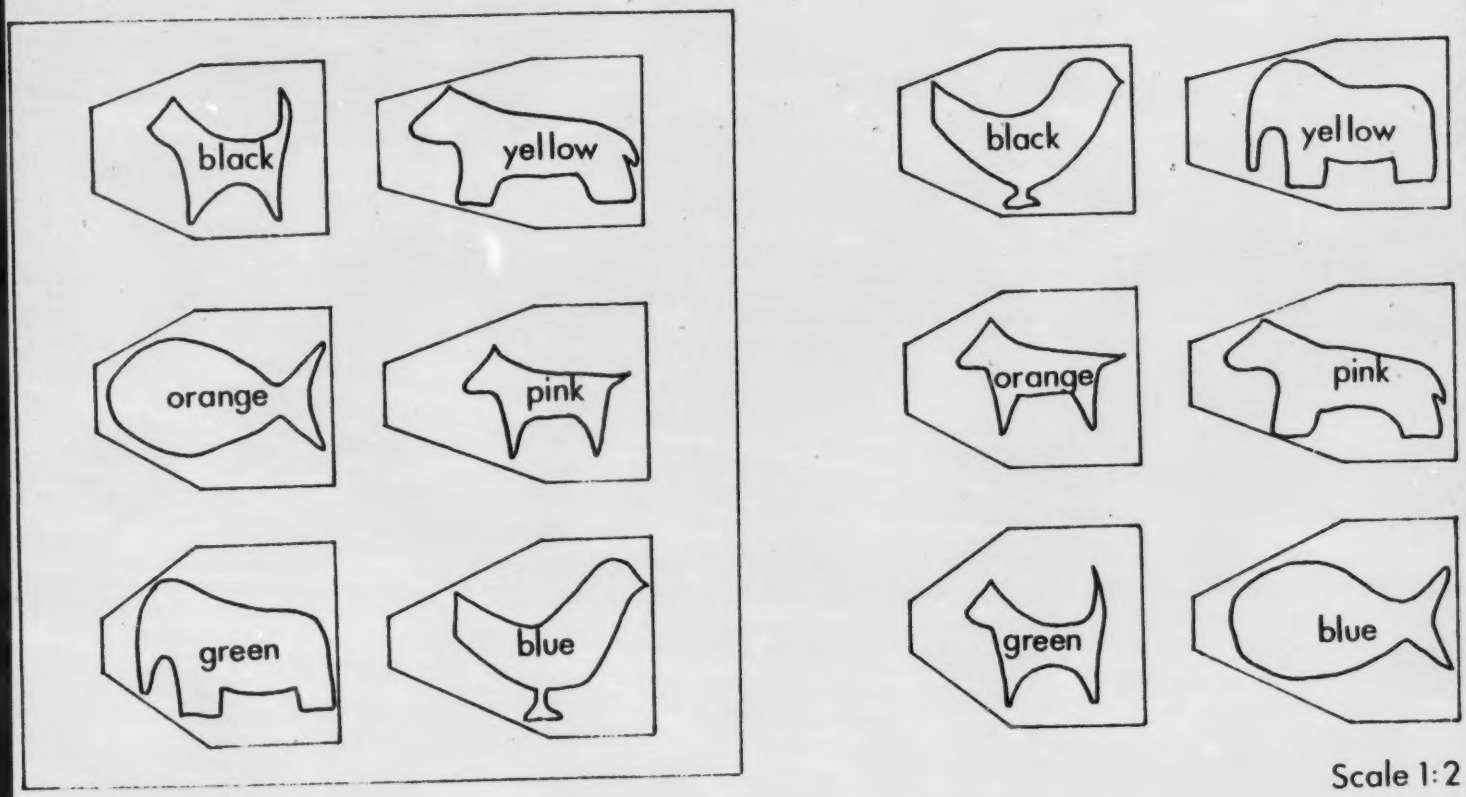

FIGURE 1

COLOUR(REPRESENTATION) PUZZLE